JAMES (J.F.)

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THE PRESERVATION OF PLANTS AS FOSSILS.

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The subject of the preservation of plants in a fossil state is of great importance to all who look back into the past and try to ascertain the origin of our present flora. To some it matters little whether the primeval seas were filled with algæ or devoid of vegetable life; to some the species and genera which grew and absorbed the sunlight of long-ago Carboniferous times are matters of the utmost indifference. But whether of interest or not, no one can deny the value of those stores of coal which have resulted from the presence of plant life; which have given light and life to the world, and have made human existence possible in spots which otherwise would have remained desert wastes.

It is a peculiar trait of the human mind to be curious about subjects which come directly under its observation. To this trait, and to that other frequently abused characteristic — dissatisfaction, are to be ascribed many of the advances of the world. To the curious we owe the increase and perfection of our knowledge to the dissatisfied we are indebted for many improvements in our social and physical condition.

These curious folk who have delved in the bosom of the earth to gather some information relative to past conditions, have brought to light many facts of great interest. It is true we know but few of the details of the earth's history. That is one reason for the existence of that bane of the paleontologist — the imperfection of the geological record, to which constant reference is made when some hiatus becomes manifest. This being filled, it might round out some of our nearly completed theories. It might also serve to dissipate some of our crude but beloved hypotheses.

There are some statements of geologists which, although made inferentially, may be considered as having reached the stage of probability; others which may be considered certain

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ties; still others that are still highly problematical. Among the certainties may be placed that which asserts the origin of coal from forests of cryptogamous plants, in what is known as the Coal era; among the probabilities, that which says the early Cambrian and Silurian seas were filled with algæ; while among the highly problematical statements is that which asserts the preservation as fossils of much of the early algal vegetation.

When our early searchers began their investigations they frequently met with curious objects which bore no resemblance to animals, and which did not seem to be related in any way to ordinary plants. Finally, Adolphe Brongniart, in 1822, coined the genus *Fucoides*, into which he placed those fossil objects considered by him to be the remains of algæ.

It is not the intention here to enter into a disquisition on the genus *Fucoides*. That may be reserved for another occasion. It must suffice to say that the genus was eagerly accepted by the grateful students of geology, who forthwith proceeded to unload into it all the objects which were certainly not of animal origin, but which they thought must be the remains of some living thing of by-gone ages. The result of this was that before many years the genus began to overflow, and then, like an overloaded wagon, broke down. Originally designed as a receptacle for algæ, it soon contained an agglomeration of objects which bore no likeness to anything but themselves. Of late years this chaotic mass has been sifted out. Among the debris we find tracks of crustaceans, burrows of worms, trails of mollusks, marks made by trailing tentacles of medusæ, markings made by the tide or waves, rills made by running water, and holes formed by burrowing worms. The study of this mass of material has revealed the fact that those phenomena, which can be seen on the shores of our oceans, lakes and rivers to-day, were just as common in times past. We, therefore, seem justified in assuming that conditions prevailing now were in existence then.

The conditions governing the preservation of plants in a fossil state vary greatly. So, too, what may be termed the "expectation" of preservation varies. For example, a leaf or a branch falling to the ground and lying exposed to the elements is far less likely to be preserved than one which is protected from these destroying agencies. Also, a plant of a

hard, woody, vascular nature stands a better chance of being preserved than one of cellular structure; while one of a silicious nature, such as a diatom, has the best "expectation" of all three. There are certain requisites necessary to insure preservation of any plant. One of these is that it must be in a position to be almost immediately covered by some material. It may fall into the water, and sinking to the bottom of a lake, or swamp, or morass, be covered by mud or sand. Or it may lie on the sea shore and be covered by sand brought in with the tide; or finally, it may, through certain chemical properties it possesses, so act upon the stone upon which it lies as to be preserved, not in actual substance, but as an intaglio.

As now generally recognized, the plants of the Coal era grew upon the shore or in the waters of swamps or marshes situated upon or near the shores of the sea, so that the tides could enter, if not daily, at least at intervals. Oscillations of the land, an alternate rising and falling, allowed the sea ingress, and then was deposited a mass of sand or gravel which compressed the vegetable matter lying on the bottom, and under the pressure turned it into coal. In this way was preserved not only the outline, but the actual substance of the plant. This, however, is not always the case. Very frequently leaves occur in a fossil state which are impressions merely. The sandstone shows no traces of carbonaceous matter, but the outlines and the venation are as perfect as if the actual leaf were before us. In these instances the particles of organic matter have been replaced, particle by particle, by silica. This also occurs in those cases when branches or leaves are immersed in hot water, having silica in solution, as in certain geysers of the Yellowstone region. Here, when at times a tree stands near enough to a geyser to receive the water periodically thrown up, it will be found gradually transformed into stone, suffering a living death.

Perhaps the most remarkable method by which plants or their outlines may be preserved, is by what may be termed the chemical process. The possibility of this occurred to me one day last Fall, as I walked along the street in the rain, and looked at the fallen leaves on the pavements. I first noticed numerous irregular, discolored patches on the stone slabs. Looking more closely, I found that these discolorations had been caused by the leaves, which had left their impress on the

stone. In many cases this impression was so distinct that there was no difficulty in recognizing the species. The leaves were those of the soft maple, one or two species of oak, tulip tree and sycamore. There is here a possibility of the preservation of the remains of plants, or at all events of their impress upon stone, had it occurred under more favorable circumstances. But on a pavement, where people were passing constantly, the impressions were worn off and soon disappeared. The rain, however, did not seem to wash them away, so they were something more than mere surface markings.

This method of preservation of plants has been noticed as long ago as 1858, and in the Annals and Magazine of Natural History printed in that year,* Mr. Chas. Peach published a paper in which he speaks of the "Nature-printing" of seaweeds on the rocks of one of the Orkney Islands, off the coast of Scotland. The genera and species were easily recognizable from the impressions, these being of a yellowish color on a dark background. Some of the slabs of stone were two or three feet long and half as wide, lying from one-half to one-third way between tide marks. The stones were coated with an olive-brown seaweed, *Ralfsia verrucosa*, and Mr. Peach makes the following remarks in regard to it:

"This coating may be llkened to the chemical preparation in photography, the *Ralfsia* being the sensitive part to be eaten away by its overlying corrosive brother. The impress is thus made and the stone when washed by the next flowing tide is cleared of all the vegetable matter, both of the decaying *Desmarestia* and dissolved *Ralfsia:* the picture is then beautifully shown (fixed) on the light-yellow coated slab. Not only does the *Desmarestia* destroy the *Ralfsia*, it also dissolves some of the rock; and thus, as well as the depression left by the washing out of the alga, it is engraved in the stone; and probably this depression is added to, time after time, by the carbonic acid in the sea-water, and thus the more indelible it becomes."

The writer goes on to state that impressions of this sort are quite common in various geological formations, and concludes by expressing the belief that while some of the many problematical markings may have been produced by annelids and crustacea, most of them represent algal remains. While we can not agree with this conclusion, the observations of Mr. Peach are of great interest, as indicating a method of preservation of plant impressions which has not been generally noticed or commented upon.

*3d ser., vol. ii., pp. 50-54.